THE CLAIMS:

1. A coating for a carbon-containing component, the coating comprising a material selected from the group consisting of:

non-stoichiometric silicon and carbon;

non-stoichiometric silicon and oxygen;

non-stoichiometric silicon and nitrogen

compounds of silicon, oxygen, and carbon;

compounds of silicon , oxygen and nitrogen;

compounds of silicon, nitrogen, and carbon; and

silicon.

2.The coating of claim 1, wherein the material is non-stoichiometric silicon and carbon.

3.The coating of claim 1, wherein the material is non-stoichiometric silicon and oxygen.

4.The coating of claim 1, wherein the material is non-stoichiometric silicon and nitrogen.

5.The coating of claim 1, wherein the material is a compound of silicon, oxygen, and carbon.

6.The coating of claim 1, wherein the material is a compound of silicon, oxygen, and nitrogen.

7.The coating of claim 1, wherein the material is a compound of silicon, nitrogen, and carbon.

8.The coating of claim 1, wherein the material is silicon.

9.The coating of claim 1, wherein the material is a compound of silicon, oxygen nitrogen, and carbon.

10.The coating of claim 1, wherein the coating includes multiple layers, at least one of the layers being made of the material selected from the group.

11.The coating of claim 1 wherein the coating has a graded composition through its thickness.

12.A method of applying the coating of claim 1, wherein the coating is applied by at least one of chemical vapor infiltration and chemical vapor deposition.

13.A coating for a carbon-containing component, the coating comprising a material selected from the group consisting of:

silicon (Si);

silicon oxide (SiO_x);

silicon carbide (SiC_y); silicon oxycarbide (SiO_xC_y);

silicon nitride (SiN_z);

silicon oxynitride (SiO_xN_z);

silicon carbonitride (SiC_yN_z); and

silicon oxycarbonitride ($SiO_xC_yN_z$);

wherein $x < 2$, $y < 1$ and $z < 4/3$, and at least one of x, y, and z is greater than zero.

14. An article comprising:

a carbon-containing component; and

a coating for the component, the coating comprising a material selected from the group consisting of non-stoichiometric silicon and carbon; non-stoichiometric silicon and

oxygen; non-stoichiometric silicon and nitrogen; compounds of silicon, oxygen, and carbon; compounds of silicon, oxygen and nitrogen; compounds of silicon, nitrogen, and carbon; and silicon;

where $x < 2$, $y < 1$ and $z < 4/3$, and at least one of x, y, and z is greater than zero.

15.The article of claim 14, wherein the carbon-containing component has a Carbon-fiber-Carbon-matrix; and wherein the coating is deposited on and infiltrated into the Carbon-fiber-Carbon-matrix.

16. The article of claim 14, wherein the carbon-containing component is a C-C component having a thin-gauge complex-shaped section.

17.The article of claim 16, wherein the component is part of a C-C heat exchanger.

18. A method of applying a coating onto a carbon-containing component, the method comprising:

forming a coating of at least one of silicon (Si); silicon oxide (SiO_x); silicon carbide (SiC_y); silicon oxycarbide (SiO_xC_y); silicon nitride (SiN_z); silicon oxynitride (SiO_xN_z); silicon carbonitride (SiC_yN_z); silicon oxycarbonitride ($SiO_xC_yN_z$); and related compounds having at least one of x, y, and z larger than zero, provided that if the coating is composed of a single layer of fixed composition having no more than two chemical elements, then $x < 2$, $y < 1$ and $z < 4/3$; the coating being formed by flowing appropriate chemical precursors over and around the component while the component is heated to a temperature sufficient to affect at least partial decomposition of said precursors, the flows and the heating of the component being continued until the coating reaches a desired thickness.

19.The method of claim 18, wherein the chemical precursor is selected from the group consisting of silane (SiH_4) and hydrogen for Si, and methylsilane ($SiCH_3H_3$) and nitrous oxide (N_2O) for SiO_xC_y.

20.The method of claim 18, wherein the component is placed in an enclosure prior to heating; and wherein an electric discharge is affected within at least part of the volume of said enclosure after the component has been placed therein but before said coating formation is begun so as to affect additional in-situ cleaning of said component.

21.The method of claim 18, wherein the flows and heating are controlled to form a graded coating.